JOHNSON GRASS as a weed

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UNITED STATES DEPARTMENT OF AGRICULTURE

CAUTION

Follow carefully the manufacturer's instructions on labels as to proper methods of using herbicides safely. Store the chemicals away from children and livestock. Use care in disposing of excess spray mixtures to avoid kill of desirable vegetation. Clean sprayers thoroughly after each use. If possible, use separate sprayers for the application of insecticides or fungicides to the foliage of crops.

Consult your county agent before using herbicides on Johnson grass that is growing in food and feed crops.

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JOHNSON GRASS AS A WEED [1]

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About 1830, seed of a grass from the Mediterranean area were introduced into this country by an unidentified farmer. Ten years later, the new grass was taken to Selma, Ala., by Colonel William Johnson. It grew luxuriantly in the new locality and became known as Johnson grass. Although originally introduced as a forage plant of superior quality, Johnson grass is now best known as a pernicious perennial weed.

Johnson grass competes with a variety of crops for nutrients, water, sunlight, and air. Within a few years after Johnson grass becomes established, the soil may be heavily infested with both rhizomes and seeds. In Louisiana, for example, 7 tons of rhizomes were produced per acre in the row area of a sugarcane field. In addition, 8 to 10 bushels of seed per acre may be produced.

The grass is spread to distant areas by seed, and in local areas by both seed and rhizomes. Johnson grass is common throughout most of the South, and has gained a foothold in most of the other States. Only 10 of the most northern States were not infested in 1957. Johnson grass presents a serious hazard to economical crop production in many areas of the United States, especially on river bottom soils subject to periodic flooding. In areas of this type, regional use of efficient methods of control are needed to reduce the annual losses caused by this weed.

For many years research workers tried to develop cultural methods for controlling this pest. Recently, intensive efforts have been made to develop chemical and combination chemical-cultural methods to control the weed. This bulletin discusses the control of Johnson grass by cultural, chemical, and combinations of cultural and chemical methods.

GROWTH HABITS

Johnson grass is an erect perennial plant 3 to 10 feet tall. It is adapted to a wide variety of soils, including upland clays, but it seems to grow best on porous, fertile lowlands.

Johnson grass seed and foliage are similar in appearance to those of Sudan grass, an annual grass used widely as a supplementary

[1] Former edition was prepared by M. W. Talbott, botanist.

[2] The authors express their grateful appreciation to the many Federal and State research personnel who contributed information either through published articles or by personal communications.

grazing and hay crop. The seeds of these two grasses can be identified by differences in structures of the pedicel, the short stalk on the seed that joined the seed to the seed head. The tip of the pedicel on a Johnson grass seed is knob shaped, but the pedicel tip on Sudan grass is rectangular. Sudan grass multiplies only by seed; Johnson grass reproduces vigorously by seed or by fleshy underground stems, known as rhizomes.

The rhizomes of Johnson grass vary in length from a few inches to several feet, and in diameter from one-fourth to three-fourths inch. Under favorable growing conditions, the rhizomes contain a large reserve of stored food. The rhizomes form the basis of the perennial habit through their capacity to survive moderately severe winters.

Methods of Propagation

In most areas of the United States, Johnson grass reproduces freely by seed. New seedlings, if not eliminated soon after emergence, develop rhizomes and become well established. Seedlings are especially troublesome in flooded bottom lands, since each overflow may bring in a new seed population. In many areas, even where established Johnson grass plants are effectively controlled, new seedlings continually present serious problems—the seed may remain dormant in the soil and emerge over a prolonged period. For efficient solution of a Johnson grass problem, effective methods of killing seedlings must follow the control of established plants.

In addition to its spread by seed, Johnson grass reproduces vegetatively by means of extensive rhizomes. These underground stems are classified into three groups: Primary, secondary, and tertiary. Primary rhizomes are those that are alive at the beginning of the growing season. Secondary rhizomes grow from the primaries to the soil surface and form new foliage when conditions for growth are favorable. Tertiary rhizomes are formed later in the season at the base of the new plants.

The tertiaries, under optimum conditions, may penetrate the soil to a depth of 4 feet and commonly down to 15 to 30 inches. On compact upland soils, however, penetration is usually much less. Johnson grass spreads readily from the tertiary rhizomes, since even small fragments may sprout and form new plants.

The primary rhizomes usually die during the growing season. The tertiaries and secondaries, however, live through the winter and become primary rhizomes the following year.

Factors Affecting Rhizome Growth

All environmental factors, including moisture, soil type, cultivation, and cropping systems, influence the growth of rhizomes, the depth of rhizome penetration, and the amount of food stored in these organs.

Soil type influences the growth of Johnson grass rhizomes. If moisture and nutrients are not limiting factors, rhizomes will penetrate further and attain larger diameters in

deep porous soils than in compact clay. Also, more vertical and lateral rhizome growth will occur in deeply plowed soil than in untilled soil of the same type and under the same moisture conditions. If Johnson grass is not allowed to exceed a height of 12 to 15 inches by mowing or grazing throughout the season, rhizome growth will be reduced. In some areas, adequate cultivation of crops early in the season is effective in controlling Johnson grass, especially if a large proportion of the rhizomes are dried by exposure to sunlight or wind. Poor cultivation, however, permits the grass to develop extensive rhizomes.

The effectiveness of control measures for established Johnson grass depends to a large degree on the rhizome development. For example, the grass is much easier to control in closely grazed pasture sod, where the rhizomes penetrate only to shallow depths, than on porous cultivated soil, where extensive rhizomes develop.

CONTROL BY CULTURAL METHODS

Cultural methods are generally effective in controlling Johnson grass. The overall objectives of any good cultural control program are: (1) To weaken and kill existing plants and their attached rhizomes and prevent formation of new ones; (2) to control seedlings growing from seed already present in the soil; and (3) to prevent production of seed.

Cultural control practices in one section of the country may not be as effective as in other sections, because of different soils, climate, and other environmental conditions. For these reasons, consult your State or local agricultural authorities for the latest local information available on the control of Johnson grass before a control program is developed on your farm.

Crop Rotation

The proper rotation of crops will reduce losses caused by moderate stands of Johnson grass. Any rotation that provides adequate competition for Johnson grass top growth and limits the development of rhizomes will aid in controlling this weed.

In the Southwest, an effective crop rotation consists of 2 to 4 years of alfalfa, 2 years of cotton, and 1 or 2 years of small grain. If desired, another row crop may be substituted for cotton. If the infestation of Johnson grass is heavy, either pasture or summer fallow and disk or plow frequently during the summer preceding the second year of small grain. While proper crop rotations may not eliminate all the Johnson grass plants, you can obtain good control and be able to eliminate the remaining spots with herbicides.

Fallow Plowing or Disking

Close mowing or grazing for 1 to 2 years followed by a thorough plowing in late fall will reduce Johnson grass stands. Where possible, plow the ground so that the maximum number of rhizomes will be thrown to the surface and exposed to winter freezes. During the

grazing or mowing period, do not permit the grass to reach a height of more than 12 to 15 inches. In some areas the above procedure has killed all but occasional plants.

In Louisiana, 6 to 8 fallow plowings during the spring and summer are effective in controlling established Johnson grass in sugarcane areas. Plowing at 2-week intervals is more effective than mowing.

In the Southeast, deep diskings throughout the summer control Johnson grass on clay soil. This treatment is most effective during dry summers. Disking before the grass is 15 inches tall gives the best results. Delay of disking treatments until later in the season is considerably less effective.

In the Southwest, plowing is more effective than disking.

Pasturing and Mowing

Pasturing has long been recognized as a method of keeping Johnson grass under control. Pasturing also makes the weed more susceptible to other treatment procedures. If Johnson grass sod is closely grazed two or more seasons, the plants become weak or stunted and the rhizomes are formed near the soil surface and are relatively short and thin. Pasturing alone, used over a period of several years, will reduce the stand considerably. If the plants attain a height of more than 12 to 15 inches, clip them to reduce rhizome development and seed formation. If production of a cultivated crop is desired after 1 or 2 years of pasturing, allow one season of summer fallow with frequent diskings or plowings prior to planting the crop.

Mowing Johnson grass will have much the same effect as grazing. In Alabama experiments, the most frequent clipping schedule eventually resulted in the least growth of foliage and rhizomes. At Stoneville, Miss., disking and mowing were compared as control methods. Disking the Johnson grass 5 to 7 times during the summer gave much better control than 6 to 10 mowings.

Other Cultural Methods

Geese are sometimes used to graze Johnson grass in cotton. The geese pick the young grass but do not injure the cotton. Best results are obtained when both the grass and cotton are small and before the hottest part of the season has arrived. The Johnson grass should be less than 6 to 8 inches in height. Usually, control of the grass requires geese at the rate of 1½ to 3 per acre, depending on the amount of grass present in the field.

If properly fertilized and managed, alfalfa provides good direct competition for moderate stands of Johnson grass. Also, the frequent clippings for hay ordinarily used in alfalfa production tend to restrict the development of Johnson grass rhizomes.

In Arizona, butane-propane burners are yielding promising results in controlling Johnson grass. These burners have a temperature of approximately 3000° F. at the burning point. On canals, both concrete lined and unlined, 11 burnings at 2-week intervals were effective for control of top growth. No regrowth occurred on the area the following season.

CONTROL BY CHEMICALS

Several herbicides have been used successfully to control Johnson grass. Since the performance of herbicides is affected by soil types and weather conditions, consult your local experiment station or county agent on the effectiveness of herbicides in your locality before you purchase the chemicals.

Soil Sterilants

SODIUM CHLORATE is used as a semipermanent soil sterilant for Johnson grass control. The sterilant renders the soil unproductive for 6 months to 3 years, depending principally on the soil texture, amount of rainfall after application, and the rate of chemical used. In arid areas of the West the soil may remain unproductive for several years. On sandy soils in the humid Southeast sterility of a few months will occur.

The effectiveness of sodium chlorate depends primarily on the soil texture and the amount of rainfall after application. Since chemical action takes place principally through the soil, enough moisture is needed to move the herbicide down to the zone containing the greatest concentration of Johnson grass roots. Too much rain will tend to leach the sodium chlorate from the zone of root concentration and will reduce or eliminate herbicidal effectiveness.

If adequate rainfall occurs after treatment, sodium chlorate can be applied at any time of the year. Acre rates vary from 100 to 600 pounds. If the Johnson grass has been mowed, pastured, or fallowed, 100 pounds per acre of the herbicide is adequate for control in some areas. On undisturbed stands, 300 to 600 pounds per acre usually is effective.

The higher rates are required in areas of high rainfall and high temperatures. Some retreatment of escaped plants may be needed.

Certain precautions should be observed when sodium chlorate is used. The chemical is corrosive to many metals. Therefore, clean all spray equipment promptly and thoroughly. *Also sodium chlorate is a fire hazard if it is combined with inflammable materials such as clothing, shoes, hay, wood, or weeds that have been wet with a sodium chlorate spray.* Wash clothing that is worn during spraying before it is reworn. Do not smoke near the spray material and observe all other safety precautions. Use of formulations of sodium chlorate that contain a fire retardant will greatly reduce the fire hazard. One fire-retarding solution is made by mixing 1 pound of calcium chloride with each 2 pounds of sodium chlorate used.

SODIUM TRICHLOROACETATE (sodium salt of TCA) gives satisfactory control of Johnson grass in many areas. Like sodium chlorate, entrance into the plant is primarily through the roots; consequently, enough rainfall is needed to leach the chemical down to the roots but not through the topsoil. In sandy soils TCA may be quickly leached out of the topsoil by heavy

rains. The residual activity of TCA usually lasts 30 days to 24 months. The length of time that the soil may be unproductive depends on the amount of TCA applied, the soil texture, the average temperature in the area, and the amount of rainfall.

The rate of TCA used will depend to a large extent on the previous history of the Johnson grass stand. If the stand has been plowed, disked, mowed, or grazed closely, 40 to 50 pounds per acre of TCA (acid-equivalent basis) will usually give satisfactory control. On vigorous stands that have received no previous cultural treatment, 100 to 200 pounds of the chemical normally give good control. No general agreement is available on the most effective date of application. Adequate soil moisture at the time of treatment and thereafter appears to be more important than stage of growth of grass or the season.

MONURON (3-(p-chlorophenyl 1,1-dimethylurea)), a relatively new soil sterilant, appears promising for Johnson grass control. The period of soil sterility with monuron will vary from 1 to 5 years. In 1957, rates of 40 to 80 pounds per acre were recommended. The lower rates have not been too effective.

OTHER TEMPORARY OR SEMIPERMANENT SOIL STERILANTS, such as arsenicals and borates, are often applied along fence rows or on utility areas. *If poisonous compounds, such as arsenicals, are used, exercise proper safety precautions.*

Contact Herbicides

In Arizona, herbicidal oils give effective Johnson grass control when used properly. The most satisfactory materials are undiluted aromatic oils, which are applied at 4-week intervals (fig. 1). The total amount of oil necessary for one sea-

FIGURE 1.—Application of herbicidal oil for Johnson grass control on canal banks. (Courtesy of the U. S. Bureau of Reclamation.)

son ranges from 500 to 725 gallons per acre. About 160 gallons is needed for each application.

Make the first application early in spring before the Johnson grass has reached a height of 12 inches. Do not allow the grass at any time during the season to reach a height of more than 12 inches before you apply the oils. Well-timed follow-up applications are necessary to control established plants (fig. 2). As the stand of Johnson grass thins out, apply less oil per acre. Control any seedlings that may later re-infest the area with oils or oil-water emulsions.

According to Arizona experiments, a herbicidal oil having the following specifications is satisfactory for Johnson grass control:

A. P. I. gravity	Maximum, 20°.
Initial boiling point	400° F.
End point	700° F.
Aromatics	Minimum, 65 percent.
Interfacial tension	5 dynes per centimeter.

Translocated Foliage Sprays

DALAPON (2,2-dichloropropionic acid) is a promising foliage spray. Dalapon is formulated as a water-soluble salt and is similar to TCA in physical appearance. However, dalapon, unlike TCA, is readily absorbed by Johnson grass foliage and translocated to the underground roots and rhizomes. Under most conditions, dalapon is broken down in the soil rapidly and consequently does not sterilize the soil for an extended period of time.

FIGURE 2.—Johnson grass controlled by herbicidal oil applications made the preceding year. Untreated bank is in background. (Courtesy of the U. S. Bureau of Reclamation.)

This herbicide has given variable results in different sections of the country. In general, 10 to 40 pounds per acre (active-ingredient basis) are required to control established Johnson grass on noncropland. In California, satisfactory results are obtained with 2 treatments of 20 pounds each of dalapon when Johnson grass is at the full vegetative to flowering stage. In Arizona, best results are obtained with 2 or 3 treatments of 20 to 40 pounds, when the first spraying is initiated during the midsummer months.

Research indicates that dalapon is more effective when the relative humidity is high. On soil typical of the Piedmont Plateau, 2 applications of 5 pounds each of dalapon during early spring on young foliage of Johnson grass gives excellent control (fig. 3). The increased effectiveness with smaller amounts of dalapon in Georgia may be due to shallower penetration of the Johnson grass rhizomes into the compact clay soil, making the grass easier to kill. Amounts of dalapon required for control of established Johnson grass in the Mississippi Delta are higher than on Piedmont soils, but are lower than in the Western States.

As results with dalapon vary widely, consult your county agent or State agricultural experiment station.

In most cases, followup sprays or appropriate tillage practices will be needed to kill Johnson grass seedlings that emerge after the established plants are controlled.

Cost of Chemicals

The cost per pound of herbicides varies among materials. This makes it difficult for a farmer to know whether the spray that he selects is the most economical one.

FIGURE 3.—Johnson grass on left was treated with 5 pounds of dalapon, then treated again with 5 pounds 10 days later. Untreated plants are on right. Photographs were made 4 weeks after spraying.

Each Johnson grass problem must be carefully analyzed to determine which herbicide is needed. Then the farmer should determine which chemicals are available in local stores. Using the cost data and information on the relative effectiveness of the herbicides available, he can estimate whether the herbicidal treatment selected is economical or not. The farmer will need additional material for followup treatments for plants that escaped first application.

COMBINATION CONTROL METHODS

In Growing Crops

COTTONFIELDS permit effective use of herbicides for spot treatment of Johnson grass. In Texas, various herbicidal oils are recommended for spot treatments. Start treatments before the Johnson grass shoots are 6 inches tall. Apply the oils to the base of individual Johnson grass stems at 7- to 10-day intervals throughout the season (fig. 4). Do not permit the oils to come in contact with the cotton plants, as injury will result. Apply the herbicidal oils with tractor, knapsack, or gravity-flow sprayers. These treatments give best results where the stand of Johnson grass is not dense.

Dalapon, at rates of $\frac{1}{5}$ to $\frac{1}{4}$ pound per gallon of water, may be used for spot control of Johnson grass infestations. Cotton is severely injured or killed if the herbicide contacts the cotton plants.

Chemical sprays are usually faster, more economical, and more effective than hand labor for controlling scattered spots of Johnson grass in row crops.

CORNLAND ON RIVER BOTTOM OR FLOOD PLAIN SOILS usually contains numerous seeds and rhizomes

FIGURE 4.—Application of herbicidal oils with gravity-flow sprayers for the control of Johnson grass in cotton. (Courtesy of the Texas Agricultural Experiment Station.)

of Johnson grass. Overflows increase or renew infestation of this weed. This reinfestation is most severe in the area southward from the 40th parallel, which includes the flood plain soils of Ohio, Indiana, Illinois, Iowa, and Missouri. Practices, developed by the Ohio Agricultural Experiment Station, that are effective for temporary control of Johnson grass on these flooded soils are: (1) Keep the Johnson grass below a height of 12 inches until late June by pasturing or cutting for hay; (2) plow the ground thoroughly by July 1, when the tallest Johnson grass plants are 12 to 15 inches high; (3) plow and disk thoroughly every 2 weeks until about September 15, keeping the soil worked up so that the Johnson grass does not exceed a height of 6 to 8 inches; (4) plant barley, wheat, or a rye-vetch mixture in the fall; (5) plow the following May, plant to corn, and cultivate thoroughly to control Johnson grass seedlings and discourage rhizome development.

For somewhat better control of very dense Johnson grass stands, follow steps (1), (2), (3), and sow winter barley as in step (4), then harvest the barley the next summer. Repeat steps (2) and (3) throughout the second summer and sow barley as a winter cover crop. Plant corn the third summer, preferably by checking, so that cross cultivation can be used. These practices may permit the production of corn a second year if the scattered Johnson grass plants that remain are rogued or are killed by chemicals. Vary these control methods to meet the requirements of other crops.

Late plowing is another control method for Johnson grass on flooded soil in the Midwest. Plow the soil in April, harrow thoroughly in mid-May, and rework it about June 1 before planting the corn. The late seedbed preparation destroys the early crop of Johnson grass seedlings. Late plowing may not be so effective for dense stands of grass as the detailed methods outlined above, but try late plowing first on light or moderate stands, since little additional labor or expense is involved.

It is not possible to obtain permanent control of Johnson grass on soils that are frequently flooded with water containing Johnson grass seed or rhizomes.

Sugarcane farmers practice fallow plowing before planting as the best method to control established Johnson grass. According to the Louisiana Agricultural Experiment Station, six to eight thorough plowings throughout the summer are necessary to kill established Johnson grass plants and rhizomes.

For the plant-cane crop, a good chemical control program is required to minimize reinfestation of the area by Johnson grass seedlings. For sugarcane planted August 1 to October 15, apply a preemergence spray containing 1 pound (acid-equivalent basis) of an amine salt of 2,4–D (2,4–dichlorophenoxyacetic acid) per acre on a 36-inch band centered over the row. Approximately 3 weeks later, apply 4 to 7 pounds per acre of TCA (90-percent formulation) on a 24-inch band. In

addition, cultivate the middles and hand-rogue to destroy the grass.

For spring treatment, apply 4 pounds per acre of TCA as a spray on a 24- to 30-inch band centered over the row. One month after this treatment or after fertilizing the cane, apply 4 pounds of TCA plus 1 pound of 2,4–D on a 24- to 30-inch band. At lay-by time, broadcast spray 2,4–D at the rate of 2 pounds per acre. Some hand roguing may be necessary before and after lay-by time.

For badly infested stubble cane, the following measures are recommended after the cane is shaved and off-barred: (1) Spray with 11 pounds of 90 percent TCA plus 1 pound acid equivalent of amine 2,4–D per acre on a 24- to 30-inch band (fig. 5); (2) before the Johnson grass reaches a height of 10 inches, apply a spray containing 4 pounds of dalapon if needed; (3) at lay-by time, apply a broadcast spray of 2 pounds of 2,4–D.

For spot infestations of Johnson grass, apply 1 pound per acre of 2,4–D on a 24- to 30-inch band after the cane is shaved and off-barred.

FIGURE 5.—Stubble sugarcane in foreground was treated with herbicides for Johnson grass control. Compare with untreated row in background. (Courtesy of the Louisiana Agricultural Experiment Station.)

Later in the season, use one of the following solutions:

(1) One to one and one-half pounds of sodium chlorate plus ½ to ¾ pounds of calcium chloride per gallon of water. Calcium chloride reduces the fire hazard of sodium chlorate.

(2) Three-fourths pound of 90 percent TCA per gallon of water.

(3) One-fourth pound of 85 percent dalapon per gallon of water.

FOR OTHER ROW CROP AREAS, apply treatments used for cotton to control scattered clumps of Johnson grass. Do not touch crop plants with spray materials, as the plants may be severely injured or killed.

ALFALFA is the only forage crop in which research on control of Johnson grass was promising. In preliminary Ohio tests TCA and dalapon partially controlled Johnson grass in alfalfa.

As Preplanting Treatments

In Mississippi and Georgia experiments, preplanting treatments for Johnson grass control were encouraging. Dalapon, at rates of 8 to 20 pounds per acre, was sprayed on young Johnson grass foliage. Two weeks after the treatment, the area was thoroughly disked. Corn and cotton were planted 2 weeks after disking, or 4 weeks after spray application. The crop plants were not permanently injured, and Johnson grass control was good to excellent. Under dry soil conditions, increased injury to crops may occur. Utilization of this method would permit control of established Johnson grass and the production of a crop during the same season.

In Ohio, preplanting treatments were less satisfactory.

GENERAL RECOMMENDATIONS

Before control measures for Johnson grass are initiated, consult local agricultural authorities, as results have varied under different soil and climatic conditions.

One or more of the following practices may be necessary to control Johnson grass:

Mow frequently or pasture for several years to weaken or partially control Johnson grass stands.

Plow or disk fallow land regularly and thoroughly before Johnson grass reaches a height of 12 to 15 inches.

Use crop rotations that employ the above-mentioned cultural practices.

If possible, utilize effective cultural procedures before treating with chemicals, to increase the effectiveness of herbicides.

Treat spot infestations of Johnson grass in cultivated crops with dalapon or herbicidal oils.

Where crops are not growing, spray aromatic oils as contact herbicides at 160 gallons per acre at 4-week intervals; or dalapon as a translocated foliage spray at 10 to 40 pounds per acre.

On ditchbanks, terraces, and headlands, use soil sterilants such as sodium chlorate at 100 to 600 pounds per acre; TCA at 40 to 200 pounds: or monuron at 40 to 80 pounds

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